Influence of Fly Ash on Rubberized Concrete

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Abstract

An experimental study had made on waste product and utilizing it for manufacturing of concrete. The disposal of waste tires is becoming a major waste management problem in the world at the moment. The results of an experimental investigation to study the effects of partial replacement of cement with flay ash in rubberized concrete. The percentage of rubber used in this study was 5% replaced with coarse aggregate and fly ash varies from 0-20% were replaced with cement in conventional concrete. One size of tire rubber chips are used of about 10mm.The mix design was targeted to be M35 grade of concrete. The mix proportion of concrete was 1:1.8:2.41 with water cement ratio of 0.45.The fresh and hardened properties of rubberized concrete produced at three different replacements ratios of fly ash compared to the conventional concrete without rubber and fly ash. A total of 85 cubes, cylinders and beam specimens were cast with the replacement of cement by fly ash with the proportion of 10, 15, and 20% and coarse aggregate by waste tyre rubber with the proportion of 5%by weight and compared with 21conventional specimens. The test result indicates that there was a small reduction in the strength with the 5% replacement in rubber content as compared with the conventional concrete. However, the increase of fly ash from 10% to 15% to 20% improved the mechanical properties of rubberized concrete. Finally it will suggest 20% replacement of fly ash with cement and 5% of waste tyre rubber with coarse aggregate will gives optimal and safest replacement in concrete composites.

Keywords: Fly Ash, Rubber, Coarse Aggregate, Fine Aggregate, Cement

I. INTRODUCTION

In 1990, over 240 million scrap tires were discarded in the United States [United States Environmental Protection Agency, 1993] and approximately 3 billion waste tires had accumulated in stockpiles or uncontrolled tire dumps throughout the country, with millions more scattered in ravines, deserts, woods and empty lots [Everett, et al 1998, Jang, et al 1998 and Brown, et al 2001]. Each year, over 77% of the annual production of scrap tires, about 188 million tires per year, were land filled, stockpiled or illegally dumped [United States Environmental Protection Agency, 1993]. Tires are bulky, and 75% of the space a tire occupies is void, so that the land filling of scrap tires has several difficulties: Whole tire land filling requires a large amount of space. Tires tend to float or rise in a landfill and come to the surface. The void space provides potential sites for the harboring of rodents. Shredding the tire eliminates the above problems but requires high processing costs. Because of the above difficulties and the resulting high costs, tire stockpiles have turned up across the country. These waste tires represent a significant environmental, human health, and aesthetic problem. Waste tires pose a health hazard since tire piles are excellent breeding grounds for mosquitoes. Because of the shape and impermeability of tires, they may hold water for long periods providing sites for mosquito larvae development. Waste tires also pose a serious fire hazard since waste tires and waste tire stockpiles are difficult to ignite. However, once ignited tires burn very hot and are very difficult to extinguish. This is due to the 75% void space present in a whole waste tire, which makes it difficult to quench the tires with water or to eliminate the oxygen supply. In addition, the doughnut-shaped tire casings allow air drafts to stoke the fire. A large tire fire can smolder for several weeks or even months, sometimes with dramatic effect on the surrounding environment. In 1983, a 7-million-tire fire in Virginia burned for almost nine months, polluting nearby water sources [United States Environmental Protection Agency, 1993]. By 1998, 48 states had passed scrap tire laws, regulations or amendments and 34 states provide market incentives to regulate scrap tires. Thirty-five states had banned whole tire land filling, and eight states had banned any scrap tire land filling. Only six states did not have any landfill restrictions on tire disposal. Sixty percent of scrap tires have been recycled and the stockpiles have decreased to about 500 million tires. Even though the situation in the United States has improved, tire stockpiles still exist and pose a threat to public health and safety.

II. STUDY METHODOLOGY

This study is mainly divided into four stages, the first stage dealt with material collection. In the second stage the preliminary tests were the third stage dealt with casting of cubes, cylinders, and beams. At last the final stage the, compressive strength, tensile strength and flexural strength tests were conducted.

A. Material Collection

First, the material is collected either from the dump yard or directly from the site. Then it is transported to the unit where crushing is done.

B. Material Investigation

Cement is a basic requisite for any construction work and also provides a binding medium for the discrete ingredients. In the present study Ordinary Portland Cement of 53grade, this is readily available issued. The specific gravity of cementis3.15.Natural River sand passing through 4.75mm IS sieve issued for making concrete.

Fig. 1: Fly ash

III. PROPERTIES OF FLY ASH

Fineness of fly ash is a single important physical characteristic, which influences the activity of fly ash more than any other physical factor. Fineness is defined by specific surface in cm2/gram. The particle size of a fly ash ranges from 120 to less than 1 micron in equivalent diameter. And, the particle size distribution mainly influenced the fly ash reactivity at early ages. It contains a shape of spherical glassy particles (solids or hollow particles called cenospheres), irregularly shaped (angular as well as rounded).The density of a fly ash depends on the constituents such as iron, silicon, aluminium, silica and carbon contents, tends to lower the density. It generally varies between 1.97 to 2.89 gram/cm^3, which is approximately 2/3 of that of Portland cements. The colour of fly ash may range from light gray to almost black depending on the type and quality of the coal and combustion process. The specific gravity of fly ash varies from source to source, the specific gravity of solid fly ash particles ranges from 1.97 to 3.02.

Table – 1
Properties of Fly Ash

S. No	*Properties*	*Range*
01.	*Percent passing 75 micron I.S sieve*	*71.4 to 95.90*
02.	*Percent Passing 45 micron I.S sieve*	*45.0 to 88.80*
03.	*Fineness(Blain's air method)(cm2/gm)*	*3300 to 6250*
04.	*Lime reactivity(kg/cm2)*	*50 to 62.40*

IV. PROPERTIES OF SCRAP TYRE

The unit weight is the ratio of the weight of a substance to the volume of a substance, whereas specific gravity is the ratio of the unit weight of solids divided by the unit weight of water. A material whose unit weight of solids equals the unit weight of water has a specific gravity of 1.0. The specific gravity of tire shreds ranges from 1.02 to 1.36, depending on the amount of glass belting or steel wire in the tire (Edil and Bosscher, 1994; Zimmerman, 1997; ASTM, 1998). Tire shreds that have high specific gravity generally possess a greater proportion of shreds with steel belts. The specific gravity of soils typically ranges from 2.6 to 2.8, which is more than twice that of tire shreds. The tire shreds tested ranged in size from 0.08 inches to 5.5 inches. Based on these tests, the dry unit weight of tire shreds was found to vary from 15 pcf (pounds per cubic feet) for a loose tire shred mix containing shreds of 0.08 to 1 inches in size to 53 pcf for compacted tire shreds of 1 to 3 inches in size.

Fig. 2: Scrap rubber tyre

A. Mix Design

Mix design was carried out as per Indian Standard Code Method (IS10262–2009) forth test specimen. The mix design was,

Table - 2
Mix proportion

S. No	Grade of Concrete	Target Mean Strength N/mm^2	W/C Ratio	Mix Proportion
1.	M35	38.25	0.45	1:1.8:2.41

Table - 3
Material quantity for 1 cube

S.no	% Replacement	Cement in kg	Fly ash in kg	Fine aggregate in kg	Scrap tire in kg	Coarse aggregate in kg	Water in liters
01.	0%(Conventional)	1.43	0	2.585	0	3.461	0.68
02.	Fly ash 10%,Scrap tire 5%	1.287	0.143	2.585	0.173	3.288	0.68
03.	Fly ash 15%,Scrap tire 5%	1.215	0.214	2.585	0.173	3.288	0.68
04.	Fly ash 20%,Scrap tire 5%	1.144	0.286	2.585	0.173	3.288	0.68

Table - 4
Material quantity for 1 Cylinder

S. No	% Replacement	Cement in kg	Fly Ash in kg	Fine Aggregate in kg	Scrap Tire in kg	Coarse Aggregate in kg	Water in Liters
01.	0%(Conventional)	2.250	0	4.059	0	5.435	1.07
02.	Fly ash 10%, Scrap tire 5%	2.025	0.225	4.059	0.271	5.163	1.07
03.	Fly ash 15%, Scrap tire 5%	1.912	0.337	4.059	0.271	5.163	1.07
04.	Fly ash 20%, Scrap tire 5%	1.800	0.450	4.059	0.271	5.163	1.07

Table - 5
Material quantity for 1 Beam

S. No	% Replacement	Cement in kg	Fly ash in kg	Fine aggregate in kg	Scrap tire in kg	Coarse aggregate in kg	Water in liters
01.	0%(Conventional)	5.107	0	4.059	0	12.307	2.434
02.	Fly ash 10%,Scrap tire 5%	4.596	0.510	4.059	0.613	11.693	2.434
03.	Fly ash 15%,Scrap tire 5%	4.341	0.766	4.059	0.613	11.693	2.434
04.	Fly ash 20%,Scrap tire 5%	4.085	1.021	4.059	0.613	11.693	2.434

B. Casting of Specimens

The test cubes, cylinders & beams were cast in M35Grade by weight with water cement ratios of 0.40. The moulds of size150 x150 x 150 mm cube, 150x300 mm cylinder and 100x100x1200mm beam were placed on an even surface and the materials were mixed in hand mixer .First coarse aggregate and fine aggregate were added.

C. Experimental Investigation

A Total of 85 specimens of cube, cylinder & beam were prepared with M35 mix forth is study with 10, 15, &20 percentage of replacement of fly ash with cement and a 5% waste tire rubber with coarse aggregate. The specimen details are available in Table 5.

Table - 6
Cubes Cylinders Beams

S. No	Notations	7 days	14 days	28 days	7 days	14 days	28 days	28 days
01.	0%(Conventional)	3	3	3	3	3	3	3

02.	Fly ash 10%,Scrap tire 5%	3	3	3	3	3	3	3
03.	Fly ash 15%,Scrap tire 5%	3	3	3	3	3	3	3
04.	Fly ash 20%,Scrap tire 5%	3	3	3	3	3	3	3

D. Experimental Results and Discussions

The physical characteristics of the materials which were obtained from tests results mentioned that were made on lab:

Table – 7
Physical Characteristics

S. No	Description	Values
1	Specific gravity of cement	3.15
2	Specific gravity of fine aggregate	2.65
3	Specific gravity of scrap tire	1.5
4	Specific gravity of fly ash	1.97
5	Specific gravity of coarse aggregate	2.70
6	Dry density of coarse aggregate	1560kg/m
7	Fineness modulus of fine aggregate	2.40
8	Fineness modulus of coarse aggregate	7.20

Table - 8
Results of M35 Grade of Average Compressive Strength .N/mm2

S. No	Mix proportion	7 days	14 days	28 days
1.	Concrete mix with 100% NCA+ 100% Cement+0%scrap tire+0%Fly ash	31.7	34.3	35.8
2.	Concrete mix with 95% NCA+ 90% Cement+5%scrap tire+10%Fly ash	27.28	31.86	31.89
3.	Concrete mix with 95% NCA+ 85% Cement+5%scrap tire+15%Fly ash	29.39	32.97	33.84
4.	Concrete mix with 95% NCA+ 80% Cement+5%scrap tire20%Fly ash	31.56	34.67	35.89

Table - 9
Results of M35 Grade of Average Split Tensile Strength .N/mm2

S. No	Mix proportion	7 days	14 days	28 days
1	Concrete mix with 100% NCA+ 100% Cement+0%scrap tire+0%Fly ash	1.64	2.23	2.61
2.	Concrete mix with 95% NCA+ 90% Cement+5%scrap tire+10%Fly ash	1.46	1.98	2.38
3.	Concrete mix with 95% NCA+ 85% Cement+5%scrap tire+15%Fly ash	1.56	2.12	2.43
4.	Concrete mix with 95% NCA+ 80% Cement+5%scrap tire20%Fly ash	1.63	2.21	2.60

Table - 10
Results of M35 Grade of Average Flexural Strength .N/mm2

S. No	Mix proportion	28days
1.	Concrete mix with 100% NCA+ 100% Cement+0%scrap tire+0%Fly ash	9.5
2.	Concrete mix with 95% NCA+ 90% Cement+5%scrap tire+10%Fly ash	9.2
3.	Concrete mix with 95% NCA+ 85% Cement+5%scrap tire+15%Fly ash	9.3
4.	Concrete mix with 95% NCA+ 80% Cement+5%scrap tire20%Fly ash	9.4

V. CONCLUSIONS

1) The rubber workability decreases when we replace coarse aggregate with 5% rubber and cement by 10% fly ash.
2) Again the workability increases when the fly ash percentage increases from 10% to 15% and 15% to 20% with the same 5% of scrap tire.
3) Initially the compressive strength, split tensile strength and flexural strength of the concrete specimens were reduced at the replacement of cement with 10% of fly ash and coarse aggregate with 5% of scrap tire.
4) When the percentage of fly ash increased from 10% to 15% and 15% to 20% along with the same 5% of scrap tire, gradually the compressive strength, split tensile strength and flexural strengths have been increased to the required strength.
5) That means, here the influence of fly ash is there on the rubberized concrete.
6) The disposal of waste tires is becoming a major waste management problem in the world at the moment. So environmental concerns are also being raised against uncontrolled extraction of natural aggregates.
7) Using waste crumb tires in the production of concrete blocks, ribbed concrete block, and for paving is strongly recommended.

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